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PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of

Nobuyoshi YAGI et al.

Appln. No.: 09/769,376

Group Art Unit: 1774

Filed: January 26, 2001

Examiner: Kimberly T. Nguyen

For: RESIN SUBSTRATE FOR OPTICAL USE

DECLARATION UNDER 37 C.F.R. § 1.132

Assistant Commissioner for Patents  
Washington, D.C. 20231

Sir:

I, Nobuyoshi YAGI, do hereby declare and state as follows:

I am a graduate of Meiji University, School of Engineering, Course of Precision Engineering in March of 1987, receiving a Bachelor's Degree from said University.

I was employed by Nitto Denko Corporation in April of 1987 and have been in the employ of said company ever since.

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I was engaged in facility design, development on the appliance and research and development on the cleanup technique at the Laboratories of said Company from 1987 to 1996 and then I was engaged in research and development on the plastic substrate for liquid crystal device from 1996 to date.

I am a coinventor of the invention described and claimed in the above-identified application serial No. 09/769,376.

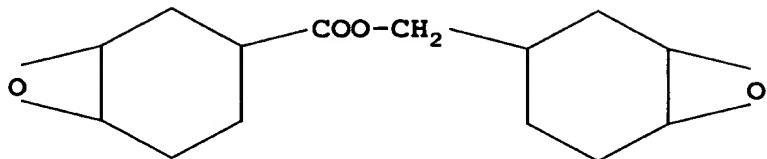
I am familiar with the Office Action dated April 11, 2002 in the above-identified application and the references cited therein.

The following experimentation was carried out by me or under my direct supervision and control.

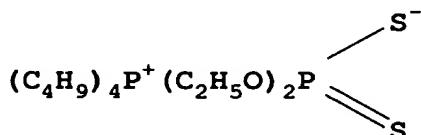
In order to demonstrate superiority of the present invention over the prior art I have conducted the following experimentation.

EXPERIMENTATION

THIS INVENTION



An epoxy resin coating fluid having a viscosity of 200 P at 25°C was prepared by mixing 400 parts (parts by weight; the same applies hereinafter) of 3,4-epoxycyclohexylmethyl 3,4-epoxycyclohexanecarboxylate, represented by the formula given above, with 500 parts of methylhexahydrophthalic anhydride, 15 parts of tetra-n-butylphosphonium  $\text{o},\text{o}$ -diethyl-phosphorodithioate, represented by the following formula, 9 parts of glycerol, and 1 part of a silicone surfactant with stirring.



Subsequently, a 17 wt% toluene solution of an ultraviolet-curable urethane resin was extruded through a

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die by the flow casting method shown in Fig. 1 of the present application and applied to a stainless-steel endless belt which was kept running at a constant speed of 0.2 m/min and had a width of 500 mm and a surface roughness Ra of 10 nm. The toluene was vaporized to dry the coating. The resultant coating layer was irradiated with ultraviolet (254 nm) in a dose of 2,000 mJ/cm<sup>2</sup> by means of a low-pressure mercury lamp to cure the resin and thereby form a urethane resin layer having a width of 500 mm and a thickness of 2  $\mu$ m.

While continuing the operation described above, a 5.5 wt% aqueous solution of poly(vinyl alcohol) was extruded through a die and applied on the cured urethane resin layer by flow casting and the coating was dried at 60°C for 10 minutes to form a poly(vinyl alcohol) layer having a width of 450 mm and a thickness of 4  $\mu$ m which overlay the urethane resin layer. A pressure-sensitive adhesive tape

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employing a heat-resistant polyester base and having a width of 40 mm (MT-3155, manufactured by Nitto Denko Corporation) was adhered to the superposed layers along each edge in the width direction.

Subsequently, the epoxy resin coating fluid obtained above was continuously extruded through a 25°C die and spread in a 430 mm-wide sheet form on the poly(vinyl alcohol) layer, while continuing the operations for forming the urethane resin layer and poly(vinyl alcohol) layer and for adhering the pressure-sensitive adhesive tape and maintaining a support level of 200  $\mu\text{m}/\text{m}$ . The spread layer was cured by heating first at 90°C for 5 minutes, subsequently at 120°C for 5 minutes, and then at 140°C for 15 minutes. This heating was conducted by passing the web successively through the zones of a curing apparatus of the type in which the support was heated with hot air from the upper and lower sides, while maintaining a temperature

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change of 0.4°C/cm or smaller in the width direction for the support. Thereafter, the cured resin layer was peeled and recovered over the subsidiary drum kept at 130°C from the endless belt with the pressure-sensitive adhesive tapes together with the urethane resin layer and poly(vinyl alcohol) layer tenaciously adherent thereto. Thus, a resin substrate for optical use having a width of 430 mm was continuously obtained. This resin substrate was cut into a 430-mm square.

The thickness of the resin substrate for optical use obtained by the process described above at 240 hours after initiation of the production was measured with a laser thickness meter with respect to 60 points in an inner 420 mm-square area thereof. The average thickness thereof and the standard deviation were determined, and were found to be 400  $\mu\text{m}$  and 7  $\mu\text{m}$ , respectively. Furthermore, the surface roughness Ra of each of the front and back sides of the

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resin substrate for optical use was measured with respect to 10 points in an inner 420 mm-square area thereof, in accordance with JIS-B0601-1994. As a result, the average thereof was 0.2 nm on the free surface side made of the epoxy resin, and was 10 nm on the other surface side made of the urethane resin, which surface side was peeled from the belt.

COMPARISON

Two 450 mm-square, stainless-steel flat plates having a surface roughness Ra of 15 nm each was coated on one side with a urethane resin layer having a thickness of 2  $\mu$ m in the same manner as above. The coated stainless-steel plates were disposed so that the coated sides thereof faced each other through a spacer and a sealing material to thereby fabricate a mold having a gap width of 400  $\mu$ m. The epoxy resin coating fluid was injected into the mold and cured by heating first at 120°C for 30 minutes and then at

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150°C for 1 hour. Thereafter, the mold was opened to obtain a resin substrate, which was cut into a 430-mm square. This resin substrate was examined for average thickness, standard deviation, and surface roughness in the same manner as above. As a result, the average thickness and standard deviation thereof were 400  $\mu\text{m}$  and 9  $\mu\text{m}$ , respectively. The surface roughness Ra thereof was 15 nm on each side.

EVALUATION TEST

An ITO film was sputtered on the epoxy resin layer of each of the resin substrates obtained as above. On each ITO film was formed a rubbed poly(vinyl alcohol) film. Two such coated resin substrates were disposed face to face at a distance of 4  $\mu\text{m}$ . A commercial nematic liquid crystal containing a chiral reagent was packed into the gap, which was then sealed to form an STN type liquid-crystal cell. Thereto was adhered a phase difference film for

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compensating for black displaying. This liquid-crystal cell was examined with a polarizing microscope while applying a voltage thereto to keep the cell in the black displaying mode.

DISCUSSION AND CONCLUSION

As a result, the cell of THIS INVENTION showed satisfactory black displaying and no alignment defects were observed therein, whereas light leakage was observed in the cell of COMPARISON due to alignment defects.

Although the resin substrate used in the cell of COMPARISON had the surface roughness Ra of 15 nm on each side, light leakage was observed in the cell of COMPARISON due to alignment defects. On the other hand, the antiglare-antireflection film as described in EXAMPLE A1 of U.S. Patent 6,064,524 to Oka et al. seems to have the surface roughness Ra of about 110 nm on one side, because the fine uneven surface on the antiglare-antireflection

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film was formed by laminating a matte polyethylene terephthalate film having a fine uneven surface (Lumirror X-45 (trade name) manufactured by Toray Industries, Inc.) and peeling it therefrom, and according to the results of the experimentation described in the other Declaration Under 37 C.F.R. § 1.132 signed by me, the surface roughness Ra of the matte polyethylene terephthalate film (Lumirror X-45) was about 110 nm. That is, the surface roughness Ra of the antiglare-antireflection film as described in EXAMPLE A1 of U.S. Patent 6,064,524 to Oka et al. was about 7 times as larger than that of the resin substrate used in the cell of COMPARISON. Under the circumstances, I believe that any liquid-crystal cell made from the antiglare-antireflection film as described in EXAMPLE A1 of U.S. Patent 6,064,524 to Oka et al. can never achieve superior display quality.

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I declare further that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that the statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing therefrom.

Date: \_\_\_\_\_

Nobuyoshi YAGI